GCSE

Rewarding Learning

Chief Examiner's Report

Physics

Summer Series 2019

Foreword

This booklet outlines the performance of candidates in all aspects of this specification for the Summer 2019 series.

CCEA hopes that the Chief Examiner's report will be viewed as a helpful and constructive medium to further support teachers and the learning process.

This booklet forms part of the suite of support materials for the specification. Further materials are available from the specification's section on our website at www.ccea.org.uk.

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GCSE PHYSICS

Chief Examiner's Report

Overview

This was the initial awarding of grades in this specification and It was also the first time that C* grades were awarded. Centres are to be congratulated on the preparation of their candidates with many achieving the top grades. This specification saw the introduction of the Practical Skills Assessment (PSA) Unit 3. Centres did an excellent job setting up the practical activities which candidates undertook in Booklet A.

On the examination papers candidates are advised to show clearly how they get their answer, starting with the equation they plan to use. Examiners will always check that although a numerical answer is correct the appropriate physics equation is present. The rule is wrong physics, no marks. However, if the final numerical answer is wrong partial credit can be awarded to a correct and appropriate physics equation. There seems to be a growing trend that candidates present their own versions of physics equations rather than the ones present in the specification, no credit is given to such equations or to memory aids such as the Ohm's Law triangle.

Candidates can score highly when asked to plot and draw a graph. It helps examiners if the plotted points are visible. To that end a single dot does not help, as the point must be clearly plotted. I would ask centres to encourage candidates to plot data points as a dot inside a circle or a cross e.g. ◉ ✕.

Candidates used many ways to label the axes of a graph, with the quantity and its unit.

I would ask centres to develop in their candidates the accepted method of using a solidus e.g. distance/m. This method of labelling should also be used when adding quantities and unit to a table. This is the approach advocated by the Association for Science Education (ASE), and is common across awarding bodies.

I have in the past expressed concern about the quality of handwriting. There remains a significant number of candidates who present answers that are verging on the illegible. If an examiner cannot read the response, they cannot award any credit A little bit of care on the part of some candidates would benefit their final mark.

The practical activities tested as part of Unit 3 were prescribed practicals that form part of the normal teaching of the subject. Candidates scored well in this part of the assessment. It is vital that centres allow candidates to perform these prescribed practicals. This would allow any problems that could arise to be sorted out and to be understood before the possibility that such a practical task might appear as part of the final assessment.

There were several contacts made to CCEA expressing concerns about the setting up of the practical activities for this year. The nature of these concerns indicates that some centres need to pay greater attention to the prescribed practicals as part of the normal delivery of the specification. Ensuring these practicals are well covered in the normal course of teaching will avoid the need to ask CCEA for advice.

Booklet B formed the other part of Unit 3 assessment. The performance of candidates in this section was generally good. There was clear evidence that candidates did less well in those questions that tested material from Unit 1. It might be helpful to future candidates that centres devote some revision time to those practical activities from Unit 1.

Assessment Unit 1 Motion, Force, Moments, Energy, Density, Kinetic Theory, Radioactivity, Nuclear Fission and Fusion

Foundation Tier

The entry for this paper was 96 candidates. The mean score was 45.5 out of 80 marks.

The candidate performance was similar to previous years with a good spread of marks. As in previous years, some candidates found the paper to be a real challenge and struggled their way through it.

Q1 **(a)** **(i)** Many candidates failed to achieve reward from what should have been a rather simple interpretation of a graph by failing to recognise the initial 5 seconds of no motion.

(ii) The frequent error here was to calculate the acceleration using a time of 25 s.

(iii) On the whole this was well answered and credit gained with an error carried forward from Part (ii) but the unit was frequently omitted or incorrect.

(b) Calculating the distance as the area under the graph proved rather demanding for many candidates and indeed many appeared not to know this technique.

(c) The overall response on this QWC question was acceptable with most candidates achieving some credit worthy answers. Only a very small number failed to be rewarded.

Q2 **(a)** **(i)** A small number of candidates managed to provide a full statement of Newton's First Law but most succeeded to achieve partial credit.

(ii) The calculation of the resultant force was by and large well attempted.

(iii) As with Part (i) this proved demanding for many candidates.

(b) **(i)** Answers were mostly good but a reasonable number failed to achieve full credit on what should have been a simple recall response.

(ii) This was well answered by most candidates.

(iii) Many candidates thought the 2 kg mass would hit the ground first, failing to recognise that acceleration under gravity was independent of mass.

(c) **(i) & (ii)** Failure to read the question was easily identifiable in this question; candidates often calculated the correct answer but proceeded to extend their work and obtain an incorrect value which was placed on the answer line.
Part (ii) was better answered than Part (i)

(d) **(i)** Some candidates did not know the equation to calculate pressure, but the majority did and scored well.

(ii) Nearly all the candidates were aware of how the pressure related to area.

Q3 **(a)** Most candidates knew the equation for density.

(b) **(i)** A few candidates had difficulty in reading the scale on the measuring cylinder to find the volume of the brass.

(ii) Error carried forward from Part (i) allowed most candidates to achieve full credit for the density value.

(iii) Most candidates provided a credit worthy response for a precaution.

(iv) The relationship between density and volume proved to be demanding for some candidates.

(c) (i) A significant number of candidates failed to make a comparison between the inter-particle spacing for solids and gases, often giving only 'small spacing in solids' or 'large spacing in gases' and thereby achieved only partial credit.

(ii) Many candidates chose to use the generalised rule of inter-molecular spacing for solids and liquids and hence no credit achieved.

Q4 (a) The main failure here to achieve full credit lay within the explanation with candidates thinking the matt black cylinder was a better conductor or choosing to use the term 'better emitter' as opposed to 'better absorber' of radiant heat.

(b) (i) & (ii) In this simple everyday application of physics a variety of responses were offered which included rather vague and incorrect suggestions ranging from the use of double glazing, cotton and curtains to reduce heat loss through the walls.

(c) (i) The equation for work done and its use was evident on most scripts.

(ii) Candidates were either well versed on efficiency or not; some failed to rearrange the correct equation to calculate the energy required but did manage to achieve partial credit.

(iii) The equation for power and its use was well known by most candidates.

(d) (i) Naming the energy gained by the ball, when squeezed, as elastic or strain was a challenge for a significant number of candidates. Potential energy was the most quoted incorrect response.

(ii) The equation for kinetic energy was well known but its use and rearrangement proved demanding for many candidates. However, the mark scheme allowed for partial credit at various parts and the majority of candidates did achieve some reward.

Q5 (a) (i) & (ii) Rather surprisingly some candidates produced answers not worthy of credit with many simply choosing to reuse the terms presented in the stem of the question.

(iii) All candidates, bar a very small number, managed to achieve at least partial credit in identifying the radiations.

(b) (i) There were many incorrect responses in defining the half-life and this was disappointing on what should have been a straightforward recall.

(ii) Many candidates either chose to add the background count to the measured count rate or simply re-quote it as the corrected count rate. This is a simple concept within the radioactivity topic and as such many responses were disappointing.

(iii) Allowing an error carried forward from Part (ii) permitted candidates to achieve full credit and a significant number did do. However, it is worth noting that some candidates performed their calculation in reverse and obtained a larger count rate value.

Higher Tier

The entry for this paper was 2960. The mean score was 74.9 out of 100 marks.

Candidates generally performed very well in this paper. The paper allowed candidates of differing abilities to demonstrate their knowledge and skills. The paper worked well to differentiate candidates. Generally, responses were well attempted with candidates showing their working out and paying attention to units

Q1 **(a)** **(i)** This was generally well answered. Most candidates were able to label the axes, select suitable scales and draw the appropriate straight line.

(ii) Most candidates were able to recall and use the v = u + at equation to determine acceleration.

(iii) This was a straightforward application of F = ma and was generally well answered. A small number of candidates had difficulty in the use of standard index form and made a 10^n error in their calculations.

(b) **(i)** Most candidates correctly associated reverse engine thrust with maximum deceleration and steepest gradient. They usually obtained full marks here.

(ii) While many were able to find the length of the runway, weaker students often lost marks by failing to show the development of their answers. The majority of candidates divided the area under the graph into 3 or 4 sections, calculated the area of each and then added the numbers together. It was good to see that, following the comment in the 2018 legacy series report, many centres appeared to have trained candidates well in determining the area under a velocity-time graph.

(c) More able candidates scored well in this QWC question. A common mistake made by less able candidates was the belief that the speed of the car was determined at each camera and the average speed was found as the mean of these two values

Q2 **(a)** **(i)** Some candidates lost marks here because the statement of Newton's First Law was inaccurate. It was common not to mention that it applies both to objects moving with uniform speed and to objects at rest.

(ii) Most candidates obtained full marks here. A small number wrongly believed that the thrust had to be just greater than the resistive force of 55 N and offered an answer of 56 N.

(iii) This was generally well done. Some candidates applied Newton's Second Law correctly to get 16 N, but then failed to add the resistive force of 15 N to obtain the value of the thrust.

(b) **(i)** This was a straightforward question on Hooke's Law. Those who could recall the equation F = ke generally obtained full marks. A minority was unable to rearrange the equation correctly and forfeited one of the two available marks.

(ii) Most candidates preferred to obtain the extension with the 5 N load by simple proportion and then add on the length of the spring, rather than applying the F = ke equation. Both approaches were rewarded.

(c) **(i)** A surprisingly large number of candidates tried to explain the longer time for the feather to fall on Earth using an argument based on gravity and obtained no marks. Examiners were looking for an understanding that there is air resistance on the Earth but not on the Moon.

(ii) This was a simple question on the calculation of pressure and was well answered by almost everyone.

(d) This was the second QWC question on the paper and was quite well done by most candidates. Some lost marks by not identifying the energy resource to which their point was referring. A small number of candidates confused reliability with the resource's classification as renewable or non-renewable. It was not uncommon to read that wind was reliable because it would never run out.

(e) **(i)** Most candidates obtained full marks in this straightforward question on acceleration.

(ii) It was disappointing to see so many candidates trying to use distance = speed x time in order to find the height of the tower. Examiners expected candidates to realise that in this case the average speed was half the maximum speed and then use distance = *average* speed x time. Other approaches, such as use of one of the equations of motion, were equally acceptable.

Q3 **(a)** **(i)** Almost all candidates realised that the incorrect density was 1.35 g/cm^3.

(ii) Examiners expected candidates to find the mean of other three values of density. Most candidates did so and obtained full marks.

(b) **(i)** This was very well done by most candidates; they correctly calculated the volume of the brass metal to be 230 cm^3 and then used the equation for density to find the mass.

(c) **(i)** Many candidates struggled with this question on kinetic theory. Their focus was on the motion of the molecules rather than on their separation.

(ii) This question on the average separation of the molecules in ice has been asked before in recent papers. As in previous years, it highlighted candidates who believe the average separation of molecules in solids is *always* less than that in liquids.

Q4 **(a)** Most candidates knew that the thermometer in the black cylinder would show the higher reading. However, a smaller number of candidates stated that this was because the black surface was a *better* absorber of radiation than the shiny surface.

(b) **(i) & (ii)** Both parts of this question on heat loss through the walls of a house were well done.

Most gave one of the commonly used materials for insulation (polystyrene beads, mineral wool, fibre-glass wool and so on). A minority lost the mark because they simply stated wool or cotton.

(c) **(i)** This question was well done by many candidates. The most common mistake was to multiply the mass by height, rather than the *weight* by the height in order to find the work done.

(ii) Most correctly recalled the equation for efficiency. However, a minority of the candidates lost their way in rearranging the formula and multiplied the output work by 0.7, instead of dividing by 0.7.

(iii) This simple question on power was well answered by almost everyone.

(d) **(i)** Many knew that compression of the cricket ball causes it to gain strain energy. However, a minority thought the relevant energy form was kinetic.

(ii) This question required candidates to recognise that, for a given kinetic energy, the heavier ball would have the smaller speed. Only the better candidates appreciated that. The most common error in the following calculation was a failure to convert the mass from 160 g to 0.160 kg.

(iii) Most candidates could use the Law of Conservation of Energy and gained the mark for the GPE in this question.

(iv) This was a straightforward application of the equation for gravitational potential energy and was well done by most candidates.

Q5 (a) (i) Many appreciated that the random nature of radioactive decay arises because we cannot predict when a particular nucleus will decay or which nucleus will decay. A minority confused the random and spontaneous nature of radioactive decay.

(ii) A surprisingly large number of candidates failed to see that the term used to describe the phenomenon is radioactive decay.

(iii) While the table was completed well by most candidates, a minority think the electron is a particle of zero mass. This was not accepted. Some lost a mark by writing that the relative charge of the electron is 1 when the examiners required to see a figure of -1.

(b) Some candidates gave a definition of isotopy in terms of mass number and atomic number. They gained no marks because the question specifically demanded a response in terms of the particles in the nucleus.

(c) (i) The definition of half-life was well known. Most candidate picked up the mark here.

(ii) Most appreciated the relationship between background count and measured count and correctly calculated the activity of the spinach leaves as 2048 cps.

(iii) This was a challenging question on half-life. Those who recognised the time interval was 3 half-lives usually went on to score full marks. Some began their calculations by repeatedly halving the initial count and also arrived at the correct answer. Candidates who carried forward an incorrect answer of 2096 or 2144 from Part (ii) could still obtain full marks for Part (iii).

(iv) The radioactive decay equation was generally well answered. The common mistake was to write the atomic number of xenon as 52 instead of 54.

Assessment Unit 2 Waves, Light, Electricity Magnetism, Electromagnetism and Space Physics

Foundation Tier

The entry for this Paper was 125 candidates. The mean score was 42.9 out of 80 marks.

A range of marks was very much in evidence with some candidates appearing to find this a challenging paper.

Q1 **(a)** Responses here were more than often acceptable.

(b) **(i) to (iii)** Responses here were, on the whole, good and with an error carried forward from Part (ii) full credit for Part (iii) was frequently attained.

(c) **(i) & (ii)** Marking of the boundary was poorly answered but the majority of candidates recognized the effect as refraction.

(iii) Partial credit was obtained for most candidates by noting one change of the wave property.

(d) **(i)** The term echo was well known.

(ii) Many candidates appeared not to know that sound waves obeyed the law of reflection and attempted to explain their answer in terms of the observer's head position.

(iii) As in Part (ii) answers here too often failed to recognise this application in terms of the law of reflection.

(e) **(i) to (iv)** Many were aware of the everyday uses of electromagnetic waves. However, some candidates suggested microwaves for making toast.

(f) In many instances SONAR, as opposed to RADAR, was suggested for the tracking of flying aircraft.

(g) Naming two properties common only to electromagnetic waves was elusive for a lot of the candidates but partial credit was available and attained in a good number of scripts.

Q2 **(a)** Unfortunately for many candidates the reproduction of the ray diagram to show how a plane mirror image is formed appeared to be rather demanding; the main failure lay with the incident and reflected rays not obeying the law of reflection.

However, partial credit was often gained for partially correct diagrams.

(b) **(i) to (iii)** Responses here were generally satisfactory but explanation of dispersion for Part (ii) was not well answered.

(c) **(i)** Ray diagram for normal vision was well known.

(ii) & (iii) Ray diagram for long sight was generally well produced but a good number of candidates offered that for short sight. The explanation of long sight produced an array of answers with many focusing on the image being formed behind the retina as opposed to offering a physical explanation as to why this happened.

(iv) Responses here were rather varied. Even when the correcting lens was wrongly identified as concave the ray diagram showed convergence after the lens. On most occasions the rays converged to the retina but in many cases the candidate omitted to show further convergence of the rays on entering the eye.

However, most candidates attained at least partial credit for their work.

(d) On the whole responses to this QWC question were poor to slightly above average but the mark scheme to allowed credit to be transferred from one sub heading to another did work in the candidates favour; it allowed for those who definitely had an understanding of the refraction experiment to gain marks that would otherwise have been denied them.

Q3 **(a)** The circuit symbol for a fuse was not well known.

(b) Calculation of the voltage available from the battery combinations was poor, especially in the latter two when some of the cells opposed each other.

(c) **(i)** Completion of the circuit would probably be best described as average with a number of candidates failing to use the correct symbols. A common mistake was to place the voltmeter in series.

(ii) A common but incorrect explanation for the inclusion of a rheostat was to suggest that it was used to change the resistance.

(iii) A significant number of candidates failed to circle the anomalous result but surprisingly ignored it when drawing the line of best fit for Part (iv)

(iv) In what should have been a straightforward response a number of candidates chose to rule a line which did not go through all the points (except for the anomaly).

(v) The explanation of direct proportionality between V and I was generally well answered.

(vi) Calculation of the resistance value was well done with all but very few achieving at least partial credit.

(d) **(i) & (ii)** The voltage in series and parallel circuits was poorly appreciated with many confusing the two.

(iii) Circuit 2 was correctly identified in most scripts.

(iv) Calculation of the current flowing in the lamp was disappointing. Many candidates chose to use Ohm's Law which of course is incorrect physics.

Q4 **(a)** The candidates appeared to find this question on electromagnetic induction rather challenging with the vast majority gaining only partial credit of 1 or 2 marks from the 4 available.

(b) **(i) to (iii)** Responses here by and large demonstrated a candidate's knowledge of the transformer or not at all.

Many candidates scripts did attain credit at some stage.

(c) **(i)** Most candidates found this a simple task although some converted the 5 kW to 5000 W to quote an answer of 5000 kWh.

(ii) Calculating the cost for a 15 minute period proved challenging for a good number of candidates with some rather outlandish costs being offered. There was however an opportunity for partial credit if 2.5kWh was identified.

Q5 **(a)** **(i) to (ii)** Naming of the planets and the force of gravity was well done.

(iii) While most candidates identified hydrogen and helium as the main constituents of the sun there were a number who offered other combinations such as heat and light or lava and magma.

(b) **(i)** The majority of candidates achieved at least partial credit for sketching the brightness graph for this unfamiliar application.

(ii) The majority of responses were correct.

(iii) A significant number of responses focused on the aspects of fuel and food rather than the issue of the very long time required to make the journey.

Higher Tier

The entry for this paper was 2427 candidates. The mean score was 72.8 out of 100 marks.

Candidates performed very well in this paper indicating good levels of skill and effective retrieval of key knowledge. The paper allowed candidates of differing abilities to demonstrate their knowledge and skills. The range of marks achieved indicated that the paper worked well to differentiate candidates.

Q1 **(a)** **(i) & (ii)** Many candidates were able to describe the motion of particles in transverse and longitudinal waves. A significant number failed to mention vibrations or oscillations in their responses using move instead, this was considered not worthy of credit.

(b) In Part (i) most recognized the display showed 2½ waves. Parts (ii) and (iii) were generally well answered with candidates who failed to get Part (i) correct still scored well when errors carried forward were applied.

(c) **(i)** Most candidates know about the reflection of sound even if terms such as bounced were used. A small number of candidates attempted to answer the question in terms of diffraction.

In Part (ii) very few candidates struggled, a very well answered question.

(d), (e) & (f) The properties and uses of electromagnetic waves was very well answered.

Q2 **(a)** **(i)** This part produced few totally correct responses.

The reflection of the ray light from the plane mirror too often lacked the precision to show that it appeared to come from the virtual image. If candidates exercised a little more care with the drawing of the reflected ray they would gained full credit.

(ii) The term lateral inversion was not known to many. Some felt that it meant the image in the plane mirror was upside down. The only acceptable response was “left appears as right etc”, other descriptions of lateral inversion were rejected.

(b) All parts of this section were much better answered than Part (a). Most candidates were able to link the amount of refraction with change in velocity of the light. Explanations of total internal reflection were good but as in previous years the confusion over the direction of the ray of light was evident.

(c) This was very well answered. Candidates scored well in the completion of the ray diagram, measurement of focal length and application of the converging lens.

(d) The meaning of short sight was recalled by very many candidates.

This section saw some excellent diagrams showing the path through the correcting diverging lens to eye and then to the retina.

(e) The question tested knowledge of ray tracing through a glass block. The quality of written communication (QWC) was tested in this part with most candidates scored full marks with detailed answers to the various questions posed.

Q3 **(a)** Determining the resultant voltage of a number of cells connected in series, proved troublesome for many candidates, there were very few totally correct responses.

(b) The calculation of resistance in various circuits was much better answered than the preceding part.

(c) **(i)** The completion of the circuit was very well answered, and it is pleasing to note that the correct symbols for the ammeter and voltmeter were used.

(ii) The plotting of the graph and follow on questions were very well answered.

(d) Most knew that bulbs in parallel are needed to ensure each bulb is lit to normal brightness. The calculation of resistance given power rating and voltage was well answered.

Q4 **(a)** Most candidates knew about electromagnetic induction and that iron was an essential metal for the metal ring. The use of the turns ratio for the transformer was very well answered as was the meaning of an efficiency of 1.0 when applied to a transformer.

(b) This was well answered. The role of step-up and step-down transformers in the transmission of electricity produced some very good answers. A very small number of candidates incorrectly felt that a reduction in resistance as the prime reason for stepping up the voltage.

(ii) Few could adequately describe the simplest form of an a.c. generator.

Q5 **(a)** **(i) & (ii)** Most were able to deduce the effect on a star's brightness as an exoplanet passed in from of the star. They also able to recall the importance of oxygen when searching for possible light on such planets.

(iii) This part was less well answered, many responses involved vague references to light from planet as opposed to light passing through the planetary atmosphere.

(b) The Big Bang and evidence in support of it produced very good responses.

(c) The stages in the life cycle of a massive star leading to the formation of a neutron star or black hole was well answered. Many candidates scored well in this assessment of QWC.

Assessment Unit 3 Practical Skills

Foundation Tier

This unit comprises Booklet A GPY31 worth 30 marks combined with Booklet B GPY32 worth 70 marks. The entry for this unit was 47 candidates achieving a mean of 64.2 out of 100 marks

In Booklet A, the practical papers, candidates achieved good marks.

There was no evidence of candidates being under any pressure of time to complete the tasks.

Booklet A

Experiment 1

Procedure

Steps 1 and 2 Candidates often achieved full credit at this stage.

Steps 3 and 4 Completion of the table for steps 3 and 4 by and large achieved full credit; candidates who did not was due to the omission of units. However, a small number did not calculate the average time correctly or used an incorrect equation to calculate average speed.

Interpretation of data

Unfortunately, some candidates chose to draw a time – distance graph despite being asked to draw a speed – distance graph and this automatically reduced the marks available. Candidates, in several instances, failed to choose a suitable scale (to use at least half of the graph paper) for the distance axis. Labelling of the axis too often failed to include the unit. Despite being instructed to draw a smooth curve through the data points on the graph a reasonable number of candidates drew point to point or followed from one point to the next rather than looking for a smooth trend line. Surprisingly a few candidates failed to obtain the mark for Part 3, (conditions for proportionality), which should have been easily achievable.

Experiment 2

Procedure

Step 1 All but 2 candidates achieved this mark for correctly connecting the ammeter into the circuit as indicated by the tick box completed by the teacher. Completion of the table was by and large well done but failure to include a heading with units was notable in some instances.

Analysis of data

Part 1 Despite the instruction to include a heading with unit in the table a noticeable number of candidates failed to do so. In some instances, the equation to calculate resistance of the coil appeared not to be known, with incorrect versions being employed. A small number of candidates also failed to record all the resistance values to one decimal place as requested.

Part 2 This part required a straightforward interpretation which was related to the candidate's calculated resistance values. This was too often answered incorrectly.

Part 3 This part which was an explanation for the answer to Part 2 was poorly answered. Candidates did not relate their answer to the temperature of the wire, being either constant or increasing, to provide an explanation of their answer.

Part 4 The variation of resistance with voltage (at constant temperature) was not well known.

Booklet B

A range of marks was very much in evidence with some candidates finding the paper a real challenge. This may have been due to this being the first paper of its kind and perhaps candidates had less practice in reading and answering this new style when compared with the other units. Another factor to consider is this paper has questions testing topics from Unit 1, candidates were perhaps a little remote from the material that was covered in the previous year's teaching.

As in other units candidates sometimes provided their own version of equations which while understood did not adhere to the accepted or formal versions and in some cases did not gain partial credit.

Q1 **(a)** The majority of candidates achieved at least partial credit for the position, but a good number struggled to provide an adequate explanation for full credit.

(b) The main issue here was the failure to mention "distance from pivot" many simply stated "distance".

(c) A significant number of candidates made no attempt to provide construction lines to identify the centre of gravity.

(d) Relatively few managed to provide a satisfactory explanation in terms of the exact location of the metal square's centre of gravity.

(e) Only a small number of candidates gained full credit. Those who did not failed to mention "about a pivot" or reference to "equilibrium/balance of the lever".

(f) Surprisingly, for this straightforward Prescribed Practical, a significant number of candidates failed to provide the unit or offered an alternative such as N/cm or incorrectly completed the values.

(g) This proved to be a demanding exercise for most candidates, but a good number did achieve partial credit.

Q2 **(a)** **(i) to (vii)** Generally these questions were well attempted but candidates who got an incorrect answer for (ii) often offered incorrect answers for the subsequent angles.

(b) This question more than often attracted partial credit with confusion between Inverted and Laterally Inverted in evidence.

(c) **(i)** A significant number of candidates appeared to have genuine difficulty in drawing a normal to the prism.

(ii) On the whole the response was accurate but in a reasonable number of instances candidates failed to show refraction for both rays on entry to the prism.

(iii) Allowing for an incorrectly drawn normal from (i) there was scope for credit in marking the angle of refraction and some candidates attained the mark.

(iv) & (v) Responses here were rather varied and perhaps suggested there to be a guessing exercise for many candidates.

(d) **(i)** The term Spectrum was clearly well known.

(ii) Many candidates presented the colours in reverse order and in some instances failed to provide all seven.

Q3 **(a)** This QWC question on Measuring the Power of a Motor was on the whole well attempted but candidates often failed to gain full credit by omitting to mention the apparatus required to measure each quantity. It would also be worth noting that the term "reliability" when taking repeat results did not often appear in responses.

(b) **(i)** Candidates on the whole did not know the definition of 1 Watt as 1 Joule per second.

(ii) Completion of the table for full credit appeared to be rather demanding for many candidates.

(iii) Heat and sound were well known as the main contributors to energy wasted.

(iv) Calculation of efficiency was either well known or not. Some candidates spotted the fact that 63 out of 100 units of input energy appeared as useful output energy and simply used this to quote the efficiency as 0.63 or 63%.

(c) **(i) & (ii)** Interpretation of the graph attracted an array of responses with some attempting to provide a more elaborate, and often incorrect, response than was required.

Q4 **(a)** **(i) to (iii)** These questions were well attempted although some confusion between a resistor and a rheostat was evident. Completion of the circuit diagram with the correct circuit symbol for a rheostat was perhaps poorer than might have been expected.

(b) **(i) to (iii)** This was very well answered but a number of candidates did not include a unit for the graph axis.

(iv) Candidates, for (iv), frequently failed to focus on the features of the graph, straight line through the origin, to achieve full credit. A number chose to dwell on the results increasing at "the same rate".

(v) This was well answered but a number of candidates failed to show evidence on the graph, as requested in emboldened type, or chose to quote their answer as 22.5 paper clips rather than rounding to 22 whole paper clips.

Higher Tier

This unit comprises Booklet A GPY33 worth 30 marks combined with Booklet B GPY34 worth 70 marks. The entry was 2693 candidates achieving a mean mark of 76.1 out of 100 marks

Booklet A

In Booklet A the candidates generally performed quite well. The paper allowed candidates of differing abilities to demonstrate their knowledge and skills. The paper worked well to differentiate candidates. Generally, responses were well attempted but there was some evidence of candidates collaborating on the analysis parts of the questions not always to their advantage. Centres are reminded that the analysis section of the paper requires candidates to work independently. There was significant evidence that the candidates were familiar with these prescribed practical activities and were able to confidently and competently follow the instructions. Marks were generally lost through a lack of rigour in the responses rather than lack of skill.

Experiment 1

Procedure

Step 1 Most candidates recorded three attempts at time for each distance. A small number of candidates failed to record to the correct number of decimal places. The column headings were generally completed appropriately with the correct unit, but not always.

Step 2 The times recorded were generally averaged correctly and recorded with an appropriate unit. Marks were occasionally lost through not specifically stating that it was the average time or rounding errors.

Step 3 The average velocities were generally calculated correctly. Marks were often lost through incorrect units, failing to label the column average velocity or inaccurate rounding.

Step 4 The final velocities were generally accurately determined with some loss of marks through rounding errors, inappropriate units or failure to head the column final velocity.

Interpretation

Interpretation 1 Most candidates plotted graphs with appropriate scales and labels on the axes. The points were generally plotted accurately. Some points were not clearly marked and were difficult to detect. Some candidates failed to fit a straight line to the points.

Some axes failed to cover at least half of the grid.

Interpretation 2 This was a discriminating part with some candidates using an initial velocity of 0 m/s when their line did not go through the origin. Many calculated the gradient accurately. Only some candidates offered an appropriate unit for acceleration.

Experiment 2

Procedure

Step 1 Many scripts had a tick in the box on the front cover, indicating that no help was given to candidates in setting up the circuit, this allowed examiners to award the 3 marks for this step.

However, some centres had all their scripts unchecked, this was interpreted that help was given to build the circuit. This resulted in many candidates failing to be awarded the marks for setting up the circuit.

Step 2 The columns were generally headed correctly. A small number of candidates failed to include appropriate units with the quantities. Specifically, the current often had an incorrect unit of 'I'.

Step 3 Five sets of data were generally recorded by all candidates. However, some marks were deducted for values not to 1 decimal place or values that were identical to other values.

Analysis 1 The graphs were generally well plotted. Some marks were lost through transposed axes. Small or irregular scales or poor axes labelling.

Analysis 2 A ruled straight line of best fit was generally well-drawn. A few scripts contained points connected with discontinuous lines.

Analysis 3 Most candidates were able to calculate consistent resistances.

Analysis 4 This was discriminating as very few candidates connected consistent resistances with temperature control.

Analysis 5 Many candidates ticked the correct graph but this did provide discrimination.

Booklet B

Candidates generally performed quite well in this paper but there were very few scripts that gained over 80%. The paper allowed candidates of differing abilities to demonstrate their knowledge and skills. The paper worked well to differentiate candidates. Generally, responses were well attempted, but candidates often lacked detail or clarity in their explanations or descriptions and so lost marks. This was a thorough test of data handling and experimental skills and the responses generally indicated that candidates lacked practice or underestimated the demand required to gain full credit.

Q1 This question tested the candidates' understanding weight, centre of gravity and moments, and their application of the Principle of Moments.

(a) Most candidates indicated in some way that the block should be placed at the centre of the rule. Fewer candidates were able to adequately explain that this was the point where the weight acted or the centre of gravity was located. There was a lack of rigour in many explanations.

(b) Many candidates stated an accurate relationship to calculate the moment of a force but a significant number of candidates failed to sate it was the distance from the pivot.

(c) Many candidates made an attempt to indicate the position of the centre of gravity without construction lines, and some were successful attempts. A small number of candidates drew accurate construction lines diagonally and located the exact position. Some candidates drew adequate vertical and horizontal construction lines that were also sufficiently accurate for a full award. However, many candidates drew inaccurate construction lines that were not creditworthy. Again, accuracy and precision were frequently not evident.

(d) A discriminating question, as only a small number of candidates adequately described the advantage of placing the weight in terms of ensuring the weight acted exactly at the 20cm mark.

(e) Most candidates were awarded at least 1 mark for the statement that clockwise moments equalled anticlockwise moments, but very few stated the other two points to gain full credit. Often the statements lacked reference to a pivot.

(f) This was a challenging question for many candidates as they failed to recognise that the position of the weight was stated relative to the metre rule markings rather than to the pivot. Many candidates failed to offer a relevant unit for moment and often stated inappropriately Nm or N/cm. Most candidates gained 1 or 2 marks through a variety of routes. Generally, most responses were a poor application of the Principle of Moments.

(g) This was a challenging question that was well approached by the majority of candidates who recognised the need to calculate the moment to be balanced or the distance required to be awarded the first mark. However, only the better candidates managed to offer an adequate comparison of this initial determination with the moment or distance available due to the limitation of the length of the metre rule.

Q2 This question tested the candidates' depth of understanding of dispersion of multi-coloured light.

(a) **(i)** Most candidates were able to draw a normal at right angles to the side of the prism. However, a significant number of candidates drew a line at an incorrect angle or did not draw a line at all.

(ii) Most candidates identified the correct angle of incidence and were awarded credit. A small number of candidates incorrectly marked the angle of incidence between the side of the prism and the incident ray.

(iii) Many candidates were able to mark the path of the refracted rays but some refracted the rays away from the normal or confused the two colours and lost one or both marks.

(iv) Many candidates correctly marked the angle of refraction for the blue ray but some marked the angle to the red ray.

(v) Only some of the candidates choose the correct statement to show understanding of the behaviour of red and blue light.

(vi) Again, only some of the candidates choose the correct statement.

(vii) This question was very poorly answered. Very few candidates quoted all the colours of a spectrum in the correct order of increasing wavelength. Many candidates failed to state indigo and violet, instead stating just purple. Other colours were also randomly omitted. Many candidates showed a lack of understanding of increasing wavelength.

(viii) Many candidates named the effect correctly as dispersion, with wrong answers including refraction, reflection and diffraction.

(b) **(i)** Many candidates were able to recall the correct wave equation and make appropriate substitutions, but a significant number of candidates made arithmetic errors in the final determination of the speed of the light.

(ii) This was well answered by many candidates, often with an error carried forward.

(iii) This was a discriminating question with very few candidates both choosing the correct response and offering a clear explanation involving a comparison specifically of the change of speed.

Q3 This question tested the candidates' understanding of the measurement of the power of an electric motor and the analysis of linear equations.

(a) Many candidates failed to gain a full award of marks for this quality of written communication question. Candidates frequently listed the apparatus required and the measurements to be taken, but did not link the two together. Many recognised the need to repeat the timing and appreciated the advantage in averaging to increase reliability. However, many candidates incorrectly described changing the load when repeating the experiment. Most candidates stated an appropriate equation to be used.

(b) **(i)** A poorly completed question with many candidates only able to access the mark for stating the watt unit but failing to define it in terms of joules per second.

(ii) Poorly answered. Many candidates recognised that kinetic energy remained constant but did not identify the correct energy change for the potential and total energies.

(c) **(i)** This was a well answered question with most candidates describing how the motor was unable to lift loads above 8N. Some candidates described the behaviour of the load rather than the motor which did not answer the question.

(ii) This was discriminating question with only the better candidates able to find the correct value of k and the correct unit. Many candidates stated the correct substituted equation but were unable the solve it for k.

Many candidates incorrectly quoted the units.

Q4 This question tested the candidates understanding and application of electromagnets and direct proportionality relationships.

(a) **(i)** Nearly all candidates stated iron as an appropriate metal for the core of the coil.

(ii) Most candidates identified a variable resistor (often rheostat) and ammeter as the components necessary to complete the circuit. Some candidates incorrectly stated simply resistor and lost a mark.

(iii) Most candidates added accurate symbols for the electrical components but some failing to draw adequate symbols especially for the variable resistor.

(b) **(i)** Some candidates stated the variable to remain constant when the experiment was repeated as the distance between the core and the metal plate, but this was surprisingly discriminating.

(ii) Most candidates completed the table accurately for the values of the upward force on the plate.

(iii) The graphs were mostly well plotted with appropriate labels on both axes.

Again, candidates failed to mark their data points with a dot and circle or an x to clearly indicate the position. Candidates often just use a point which is not always detectable. The (0,0) point was often omitted even though this was an explicit data entry on the table. A significant number of candidates transposed their axes.

(iv) The best fit lines were mostly well placed as one single line and completed with a ruler.

(v) This part was somewhat discriminating as many candidates were able to articulate the proportionality between the force and the current but a significant number failed to state both the criteria of a straight line through the origin.

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